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SAFETY-BELTS ARE NOT DANGEROUS

BY

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For the past ten years Crash Injury Research at Cornell Medical College, in New York City, has been analysing the causes of injuries in aeroplane accidents. Under the direction of Hugh De Haven, particular attention is paid to seat belts, and medical data from hundreds of crashes show that injury from safety-belts is rare. As a result seats and belts have been strengthened in military and civilian planes. The use of shoulder harness is advocated, but when this is not available pilots and passengers are encouraged to fasten their seat belts tightly. The Cornell project has been in close touch with the authorities in Great Britain, and its work has been well summarized in a recent article by Walter Tye (1952).

The U.S. programme was going well until the appearance in this *Journal* of a report on the Viking crash by Dr. Donald Teare (1951), who stated as one of his conclusions, "The immediate cause of death in more than half of the victims was acute flexion of the body over the safety-belt." The acceptance of this conclusion was immediate and its effects were widespread, at least in America. Several journals gave it prominence. The *Scientific American* in December, 1951, headed its abstract "The Dangerous Safety-Belt." Thousands of airline passengers became apprehensive and fastened their belts loosely if at all.

Results of Research

When Cornell's Crash Injury Research was started in 1942 it was popularly believed that 1,000-lb. (454-kg.) safety-belts caused internal injuries, and even cut people in two. Since that time a careful analysis of accident details and medical data in 858 crashes has shown that there is no foundation for such beliefs. The portions of the body adjacent to and supported by the safety-belt sustain less injury than any other body area. Also, the concept of acute flexion of the spine has proved to be untenable. When the body, held at the hips by a properly applied belt, is suddenly stopped there is immediate acute pivoting at the hips. The torso and the legs hinge on the safety-belt and jack-knife forward.

The 1,000-lb. belts formerly used in United States civil aircraft often broke, and now the minimum requirement

for civil aircraft demands safety-belts with a holding capacity of 3,000 lb. (1,360 kg.). Careful analyses of several recent severe accidents in civil transports have shown bruises on the hips, but no evidence of serious flexion or belt injury.

The effect of seat belts was carefully studied in Germany during the war by Ruff (1941). With seat belts properly applied, just as they are now in British and American planes, he tested men in a swing that was stopped abruptly. The speed was increased gradually until the braking produced a maximum snubbing effect of 1,000 kg. (2,204 lb., about 14 G). He found that when the brake is applied the body goes through a pivoting movement with the belt as an axis. The body and head fly forward and downward, the legs forward and up. Ruff says, "The demands on the tissues and organs in the region of the belt were found to be entirely tolerable; in Test 7 a slight nausea occurred which lasted about an hour."

Cornell's Crash Injury Research has recently made a survey of 800 survivors in serious crashes in which the occupants were wearing seat belts. The belts were stronger than those in the Viking crash, most having a holding capacity of 2,000 lb. (907 kg.). There were 704 survivors with injuries in the head, 641 with injuries in the legs, and 250 with injuries in the combined areas of the lumbar spine, abdomen, hips, pelvis, sacrum, and perineum. However, injuries in the region of the belt (usually bruises) were sustained by a mere 32 survivors, and evidence of intra-abdominal injury was found among only 23 of the 800 survivors. Injuries from belts played a minor part in these crashes, in which exposure to belt injury was great because the belts were strong. It is not the belt that causes injury if the body jerks forward and strikes dangerous objects in the plane. Little evidence regarding belt injury can be obtained in severe crashes when the belt or its attachments break, allowing the victim to shoot forward into a mass of wreckage.

Analysis of the Viking Crash

With this background we are in a position to study the evidence presented in the Viking crash. Dr. Teare's article is important, as it represents one of the most comprehensive and careful studies of pathological findings in a severe accident. In his brief report he could not make the type of analysis that is employed by the Crash Injury Research investigators, and it is doubtful if he could anticipate the effect of his conclusions. Fortunately, analysis is now possible, since we have received a map of the landing-field showing the location of parts of the plane, photographs of the wreckage, and details of the necropsies of the 28 victims. We hope that Dr. Teare will forgive us if we differ from his conclusions.

The basic facts of the case are derived from evidence on the ground and in the wreckage. On October 31, 1950, the Viking aircraft crashed in a thick fog at London Airport. There were no witnesses; the stewardess and the one passenger who survived have no accurate recollections. Both were seated in the rear of the cabin. There were marks at the edge of the runway indicating that the craft hit the ground at an angle of about 20 degrees and a speed of 120 knots as judged from scars left by the propellers, though some estimates are as low as 80 knots. The plane bounced and then was airborne for about half a mile (800 metres), possibly out of control, before it struck the edge of a concrete runway with the right wing while flying in a right-wing-low attitude. The right wing was crushed and sheared off just outboard of the engine. The right tail plane and elevator (stabilizer) were also found in this vicinity. The ship cartwheeled, bounced, or slid 350 ft. (107 metres), hit a pile of "asbestos type" water-pipes, and came to a sliding stop. The aircraft caught fire; structures and bodies were badly burned and much evidence was destroyed.

The nature of the crash has an important bearing on the causes of the injuries. The first glancing impact could have caused little strain on the belts. The second and principal crash impact on the right wing must have thrown the

passengers heavily to the right side. Dr. A. Buchanan Barbour (1951), Chief Medical Officer of British European Airways, points out that the main force was towards the lateral aspect. The arm-rests of the chairs, being higher and more rigid than the lapstraps, may have been responsible for some of the intrathoracic, liver, and spleen injuries. It is impossible to say just when the seats broke loose, but they were stressed against almost 12 times gravity (11.7 G) in a forward direction and considerably less, approximately 5.85 G, laterally.

After this second impact there was much tumbling of the victims and the contents of the plane, with a final sliding impact against the pipes. At no time could there have been a great force from the belts themselves, since they had only a holding capacity of approximately 1,300 lb. (590 kg.), or about 7.6 G.

The Injuries

In our opinion the injuries are typical of those in severe crashes in which seats or safety-belt anchorages fail. Dr. Barbour, who visited the scene of the accident within an hour of its occurrence, says in his letter that he marvels that any living being, however seated, could have escaped from such total destruction. He points out that there were six passengers in aft-facing seats, all killed. The two survivors in the rear of the plane were sitting in forward-facing seats, but were not wearing their lapstraps.

Dr. Teare states that he believes most of the victims were dead before the outbreak of fire and that the remainder, whose injuries were very severe, were unconscious and lived only for a matter of seconds in the fire. He gives a brief table of "actual causes of death." Further information can be obtained by grouping all the injuries noted in the necropsy reports.

Injuries Reported in the 28 Necropsies

Injuries	No. of Individuals	Remarks
Fractures of skull	13	Plus 1 doubtful
Haemorrhage in brain or on its surface	20	" 2 "
Fractures of spine at C 1, 2; D 3, 6, 8, 12; L 2	7	
Rupture of aorta ascribed to puncture by ribs or vertebra, at D 4, 4, 6, 6, 8, 12; L 2	7	
Rupture of aorta without fracture	1	
Fracture of ribs	17	Total fractures 155: ribs 1-6 115; ribs 7-12, 40
Injuries to lungs	23	
" " heart	13	
Ruptures of liver	15	
" " kidneys	10	
" " spleen	10	
Fractures of sternum	4	
" " extremities	16	25 fractures, plus 7 doubtful
" " pelvis	8	
" Bursting of abdomen	1	Due to burns
Injuries to stomach and intestines	0	
" " pelvic contents	0	

The distribution of injuries in the Viking crash corresponds well with that found by the Crash Injury Research group in their study of severe crashes. Damage was least in the region held by the belt. All 28 victims had injuries to the head or upper thorax; 21 had injuries to the lower thorax, liver, spleen, or kidneys; 7 had fractures of the pelvis, but 6 of these showed multiple fractures in the upper part of the body. In one woman, badly burnt, there was "bursting of the abdomen" along with great destruction of the head and body. In all cases the stomach, intestines, and pelvic contents were intact.

Dr. Teare says, "The ruptures of the aorta were associated with fractures of the ribs, disruption of the intercostal muscles, fractures of the spine, or laceration and bruising of the anterior surface of the liver." These injuries were, in Dr. Teare's opinion, caused by "acute flexion of the body over the safety-belt." It is difficult to see how the spine could have been flexed any more acutely in this accident than in a wrestling match or football game unless the body were hurled free, striking some hard object. Dr. P. S.

Rutherford (1951) reports four cases of rupture of the aorta which he ascribes to a downward pull of the viscera. Three of these were in automobile accidents and one in a man who fell from a roof and landed on his feet.

Dr. Milton Helpern, Deputy Chief Medical Examiner for the City of New York, has been kind enough to go over the data with me. In his experience, rupture of the aorta is quite common in automobile accidents and falls from heights. For example, in New York in the year 1950 there were 15 victims of automobile accidents and 3 victims of falls in whom rupture of the aorta was given as a cause of death, to say nothing of many more cases in which it accompanied other causes of death. While reviewing Dr. Teare's findings, Dr. Helpern commented on the fact that no ruptures of the stomach, intestines, or bladder were found in the Viking disaster, yet these are frequent when the abdomen is injured. He saw no signs of damage from seat belts.

Summary

A report in the *British Medical Journal* of the Viking crash presented the conclusion that "the immediate cause of death in more than half of the victims was acute flexion of the body over the safety-belt." This report on one crash has been quoted extensively in America and has caused apprehension about the use of safety-belts by airline passengers.

Analysis of the crash conditions in the Viking crash, and of the 28 necropsies, indicates that seats and safety-belt anchorages broke, except in the case of the two survivors (who were not wearing their belts). Among the victims there was a great predominance of fractures of the head and upper part of the body. There were fewest injuries in the region of the seat belt. There is no proof that any of the injuries were due to belts.

Analysis of 858 crashes made by the Cornell Crash Injury Research project provides evidence that injuries from seat-belts are rare, even with belts and attachments much stronger than those used in the Viking.

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When visiting the Staffordshire coalfield this week the Minister of Fuel and Power declared that he was anxious to introduce a new Safety in the Mines Bill. That more attention should be given to this subject is evident to anyone reading the recent report of the Inspector of Mines for the North-western Division, Mr. G. Hoyle (H.M.S.O., 1s. 6d.). "I make no excuse," he says, "for repeating what I have said before, that among the former things which must pass away with the reshaping of the pits is the attitude that so many accidents in mines are inevitable. . . . It should be realized that many of the accidents occurring now are caused in the same way as accidents were caused 50 years ago and that the remedy in many cases is known." During 1951 in the North-western Division alone there were 23 fatal accidents, 2 less than in 1950, but reportable non-fatal accidents had risen from 152 to 173. Even more disturbing is the attitude revealed to dust suppression. "General progress in the suppression of dust has been disappointing, and at many pits there appears to be a lack of urgency on the part of both officials and workmen in dealing with this problem." Figures for 1951 show no improvement during the year in the proportion of faces in the division (62%) classed as dusty. Mr. Hoyle also reports that at a few pits there is deliberate opposition to dust-laying, shown "by the regular damaging of dust-suppression fittings."